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FUZZY LOGIC IN THE SYSTEM ARCHITECTURE OF EDUCATIONAL PROCESSES ANALYSIS

Abstract:
In our work we analyze a set of economic factors, that impacts on student's decision of educational path change. Taking into account such factors as the expected salary after graduation, educational costs, set of government exams and the amount of educational paths in the university, we estimate the possibility for each student to optimize his educational path. To describe the behavior of a rational individual and to estimate the optimal and preferred educational paths in this conditions we use the classical economic theory, the classical theory of economic behavior, the methodology of increasing efficiency of the human capital and the institutional economic theory. To estimate the possibility for each student to change his educational path we developed an approach, that is based on the fuzzy logic model of Mamdani type. According to this approach, the possibility of educational path change for a student is calculated on the panel data on the amount of perspective directions of student's graduation and educational paths, on the possibility of budget support of the graduation, on the expected salary level after graduation.

Keywords:
modelling theory, fuzzy logic, systems behavior, higher education system, educational paths, behavioral economics, economic expectancies.

Introduction

The optimal use of university's resources in this competition requires comprehensive analysis of the student's motivational factors and a deep analysis of financial effectiveness and energy efficiency in the organization of higher education. In this article we focus our research on the problem of educational process optimization, depending on the labor market demand and the student's expectancies. The choice of a university and an educational trajectory determines student's current and future personal well-being. At the same time, the choice of an educational path made by each student impacts on the further development of economic sectors. In this article we analyze student's economic motivation in the context of individual behavior theory.

According to the classical theory of individual economic behavior, decisions are based on the considerations of clear rationality. It is assumed that individuals choose the best way to maximize the utility of the obtained benefits or to search a job with the best possible future income. Along with this, it is understood that people are able to evaluate all the possible choices and understand the consequences of each option [1].

Behavioral economists assume that people react differently to equivalent situations depending on their own estimates, whether they lose or win. Pursuant to the classical theory of individual economic behavior, decisions of rational individuals are based on the considerations of clear rationality [2]. Individuals choose the best way to maximize the benefits obtained or search a job with the best possible future salary level. In terms of the theory of modern institutional economics we assume that the economic behavior of the individual is largely determined by the limitations of the institutions [3].

Modern Institutional Economics Theory argues that the economic behavior of the individual is largely determined by the constraints imposed by institutions [4, 5]. The study of economics of higher education [6] and, in particular, the economic analysis of the preferences is seen as an urgent task of researchers. Several mathematical models have been developed based on an analysis of the career choice [7, 8].

The study of economics of higher education and, in particular, the economic analysis of the preferences, is seen as an urgent task of researchers. Questions of student's economic expectations and university's entrants are widely discussed by contemporary economists. In particular, the dependence of the expected incomes after the graduation on different specialties is under investigation [9]. The state of the Russian higher education provides extensive statistic data to analyze the impact of economic incentives on human behavior. In short, the situation can be characterized following sentences: the government creates incentives for learning technical and natural sciences by providing a wide spectrum of tuition subsidies and state scholarships; the state and independent experts report about the "overproduction" of the humanities graduates (economists, students of law, managers); young people show a preference for a liberal arts education [10, 11], despite a lack of available scholarships [12, 13]; the system of the Unified State Examination (the USE) allows to formalize and to analyze the "set of opportunities" for university applicants in the search of a major.

To establish the probability of a student changing of educational path, a fuzzy logic model of Mamdani type [14] was developed according to the following parameters. 3 input rules converge into establishing the output variable of probability of change. In this way the number of possible perspective directions [15] are the first variable that affect in the decision of a student changing of program, the second variable is the probability that these students have to get budget support from the government or university to pay for their studies, and lastly the last variable is an estimate of the amount of money the students will earn as a salary when they graduate from their current program. The following step to the model is to establish the ranges that can represent through natural languages each one of the variables of the model.

The Educational Processes Analysis System

The Educational Processes Analysis System (EPAS) (figure 1) is an architecture design aimed to be used as a reference for educational institutions. Its main functionality is to provide a set of analyses and reports that can be programmed through some business rules in natural language, that depending of some input variable inputs can generate some output variables.

The core of the whole EPAS architecture is based on using Fuzzy Logic, more specifically Fuzzy Inferences Systems, which can be used in a wide range of fields, due to their outstanding ability of managing natural language variables (known for having vague ranges). For the specific scenario of the EPAS architecture, the fuzzy inference system or set of systems have the purpose of create indicators or variables of study that can facilitate the labor of analysis of Educational Factors that influence a student. One specific example is an indicator that expresses the Probability of Program Change according to factors like the possible Future Salary, the Amount of Programs Available to Change of Educational Path and finally the Probability of Getting Monetary Support or Aid.

In a normal scenario the process would involve first taking into account the different variables to create a custom model according to the needs of each educational institution, then creating the model, and lastly adjusting the model (modifying formulas) to full fill the analysis requirements, but through the implementation of an EPAS architecture educational institutes can make use of computational power to focus the efforts entirely into defining solely the business rules, which express in natural language the way the input variables relate between themselves to determine the out variable [16].

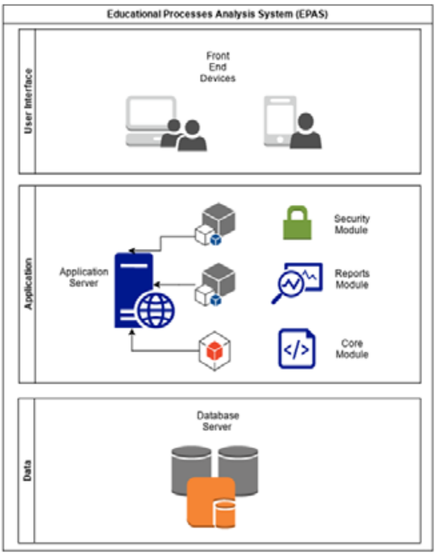

Figure 1: Structure of the Educational Processes Analysis System (EPAS)

The Model Architecture

The architecture per se it's a three-tier architecture (widely used in the IT industry) divided into three main layers: Data Layer, Application Layer and User Interface Layer. The purpose of this architecture is to divide one problem into the previously mention layers in order to decrease the dependence of the system components. To present a more concise example applicable in the EPAS context, educational institutions that implement an EPAS architecture can easily upgrade, maintain, or modify each layer of the system. More over if for instance two institutions decide to build an EPAS in a collaborative effort, they can implement the same system and just focus on change the User Interface Layer for specific branding or customized graphical features, without worrying of affecting neither the Application or Data Layer (figure 2).

The Data Layer is aimed to provide the EPAS the input data required to analyze the educational processes of the students in an educational institute, therefore it must contain the variables that are going to be used in the business rules of the Application Layer. It is important to mention that when a system is poorly design, in terms of programming a system without taking into account the expected outputs, mostly like it will not offer a useful help, if given any at all. Another function delegated to Data Layer is to serve as a register of historical data, providing reports and raw data that can be used in the future for further and deeper analyses that may involve prediction rules. Also this layer has the responsibility of store business rules for one or more processes of analysis used in the Application Layer.

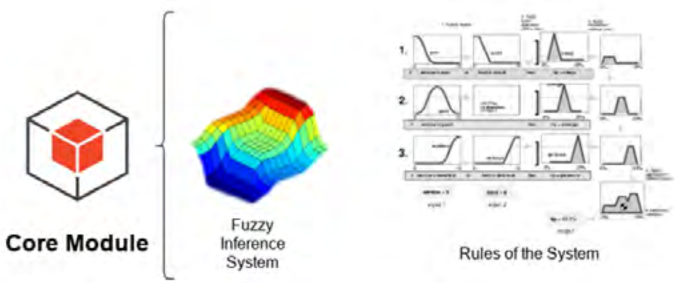

Figure 2: Model Architecture

The Application Layer is the core of the whole EPAS concept, within this layer can be found the heart of technology processes that will support educational institutions on the understanding and decision making regarding the educational processes of the students. There are three independent modules that should exist in this Layer in order to provide a minimum set of required characteristics. The Core Module provides the EPAS the ability to take larger amount of stored data in the Data Layer and process them according to fuzzy sets to generate some output variable. The processing here can be implemented in different ways, but it is suggested to use programming libraries that offer Fuzzy Logic Support for creation Fuzzy Inference Systems rather than developing a custom library for dealing with this kind of problems [17].

The Reports Module is responsible for saving the output variables generated from the processing of the Core Module into the Database, and generate reports that can be read by humans in a more comprehensive way than just raw numbers. It is recommended that the reports can be generated in various formats (eg. PDF, EXCEL, CSV, etc.) for usability and usefulness of the system.

The Security Module is designed to ensure that the generation of reports, modification of business rules and restricted access to system is ensured. For instance, some university employees can have access to the system for viewing and generating reports but the modification of business rules or access to sensitive data itself must be restricted from them.

Finally the User Interface Layer is just a proxy between the functionality offered by the Application Layer and the Data Layer. This layer can be as small or big as desired since is completely independent of the other two Layers. For example, in this Layer three different applications could be found, a Desktop Application, a Web Application and a Mobile Application. All of this applications would have their own specifications and requirements according to the educational institutions needs but they could potentially offer the same functionality.

Conclusion

To conclude its necessary to rectify that this is not the only possible solution to implement fuzzy logic systems of inference into the analysis of educational processes, but it is certainly a well known standard that any

IT department or company could implement or maintain like any other web application for example. This architecture gives the chance to departments and companies of IT to build a solution conceptually equal to other market tools but taking the advantage of using fuzzy logic to analyze the input data of an educational institution for obtaining a valuable output and understanding of the educational processes.

The fuzzy logic model allows the describing of educational path change probability. At the same time on the basis of this model it is possible to analyze the impact of student's choice on the economic sectors development. The Educational Path change probability in the current model is varied between five levels and depends on the amount of perspective directions of graduation for students, on the budget support possibility for each student and on the expected salary level after graduation. For the further research we plan to extend the model by analyzing individual's social and personal characteristics.

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